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THE FRESHWATER SPECIES OF *VAUCHERIA* (TRIBOPHYCEAE, CHRYSOPHYTA) FROM CONNECTICUT

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ABSTRACT. Having scoured freshwater habitats throughout Connecticut for more than two years at 151 collection sites, we have discovered the presence of nine species and two varieties of the genus *Vaucheria*, including four species not previously known from the state: *V. prona*, *V. taylorii*, *V. uncinata*, and *V. undulata*. In addition, *V. compacta*, normally found in local estuaries, is reported in freshwater here, and is distinguished from its local freshwater variety, *V. compacta* var. *dulcis*. Culture conditions in the laboratory stimulated production of gametangia, allowing for identification of mostly vegetative field-collected samples. A key to the species and varieties is provided.

Key Words: *Vaucheria*, Vaucheriaceae, Tribophyceae, Connecticut

Vaucheria is a yellow-green alga commonly encountered along freshwater stream and river banks, in mud surrounding small ponds and marshes, in drainage ditches alongside roadways, and in puddles and vernal pools worldwide. In habitats such as these, coenocytic siphons of *Vaucheria* act as ecologically important substratum stabilizers, often during continual environmental disruption. Although most species in the genus live in freshwater, several species are found in brackish water, and a few are completely restricted to marine environments (Blum 1972). *Vaucheria* species have been shown to be euryhaline, often tolerating great variation in salinity in very short periods of time (Schneider et al. 1993).

The first recorded collections of freshwater *Vaucheria* from Connecticut were included in the early and important North American exsiccata, *Phycotheca Boreali-Americana* (*P.B.-A.*, Collins et al. 1895, 1898, 1905). This exsiccata included three freshwater *Vaucheria* specimens from the state: *V. terrestris* Lyngb. [= *V. frigida* (Roth) C. Agardh], Fasc. II (1895), no. 78a

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(*Setchell*, 9.x.1892, Norwich); *V. aversa* Hassall, Fasc. X (1898), no. 475 (*Holden*, 3.xiii.1892, Mill R., Fairfield); and *V. geminata* (Vaucher) DC with some *V. geminata* var. *racemosa* (Vaucher) Walz [= *V. racemosa* (Vaucher) DC], Fasc. XXVI (1905), no. 1287, (*Holden*, 9.iv.1892, Ash Creek, Bridgeport). In his monographic treatment of freshwater and marine "green" algae from North America, Collins (1909) included only five freshwater species of *Vaucheria* for all of North America, reflecting the limited knowledge of the genus at that time. Of these, only *V. aversa* and *V. sessilis* (Vaucher) DC [= *V. bursata* (O. F. Müll.) C. Agardh] were reported from Connecticut. Conn and Webster (1908) published the first report on freshwater algae specifically from the state, and recorded only one species, *V. bursata* (as *V. sessilis*). Hylander (1925, 1928) included five freshwater species of *Vaucheria* in his "Algae of Connecticut," based on limited reports from throughout the state. These included *V. aversa* from Fairfield; *V. bursata* (as *V. sessilis*) from Brookfield and Middletown; *V. frigida* (as *V. terrestris*) from Litchfield, Hartford, New Haven, and New London counties; *V. geminata* from Bridgeport, Barkhamsted, and New Haven; and *V. racemosa* (as *V. geminata* var. *racemosa*) from New Haven (Hylander, 1925). Each of these species was then recorded in the first monograph of *Vaucheria* for North America by Helen Brown (1929). John Blum's (1972) later seminal monograph on the "Family Vaucheriaceae," published as part of the New York Botanical Garden's "North American Flora," included 22 freshwater and 20 marine species, but none with specific reference to the state. Since 1928, only one species has been added to the freshwater *Vaucheria* flora of Connecticut, when *V. compacta* var. *dulcis* J. Simons was found in abundant populations near the junction of the Farmington and Connecticut Rivers (Schneider et al. 1996).

Thus, in the more than a century since the first reports of *Vaucheria* from Connecticut in *P.B.-A.*, only six freshwater species have been reported. During this time, collections were made from only a few localities, mostly in the western part of the state, and only a few sites were visited throughout the year. Considering that fourteen freshwater species have been reported for New England, New York, and New Jersey (Blum 1972), not including one presently known only from Connecticut within that range (*V. compacta* var. *dulcis*), the timing seemed right to conduct a basic field and laboratory study to assess the diversity of freshwater

Vaucheria in the state, and to broadly survey the local species distributions. Only four marine/brackish species of *Vaucheria* from Connecticut were recorded prior to a similar coastal study of the genus, and five species and one variety were subsequently added to the local flora after extensive field and culture work (Schneider et al. 1993).

MATERIALS AND METHODS

Since the initiation of this study in 1994, we have visited 151 riparian and limnic habitats, muddy wetlands, drainage ditches, and roadside catchments, often revisiting the same sites in different seasons. Crude samples were collected either as siphonous algal mats attached to substratum, or mud itself with no obvious signs of *Vaucheria*. Using a flat spatula, substrata were cut into approximate 100 cm^2 quadrats, varying in thickness from 2–3 cm. At the site, after temperature was recorded for proximal standing water, pH (Corning pH 103 meter) and salinity were measured (Reichert-Jung refractometer 11719-2). Field evaluation of the substratum type (sand, mud, etc.) was made. Codes identifying the collecting sites are given in the Appendix (bold face), and numbers at the end of codes under "REPRESENTATIVE COLLECTIONS" represent the first, second, third, etc. visit/collection in the same location. Collection data are followed by the first date of gametangia appearance in culture, or noted if they were fertile in the field collection.

The crude samples were collected in labeled, zippered, plastic bags and transported on ice to the laboratory where they were immediately subdivided into three labeled culture dishes. Vascular plants, sticks, and leaves were removed from the surface. Bold's basal medium (Bischoff and Bold 1963) was added to each culture dish to a depth of approximately one-third the thickness of the crude sample. Samples were distributed among three photoperiods (8L:16D, 12L:12D, 16L:8D) in Hotpack incubators (#352642) set at 15°C, an optimum temperature for the growth of *Vaucheria* (Schneider et al. 1993). Microscopical observations on each crude culture were made every five to ten days. Drawings were made with the aid of a Zeiss camera lucida, and microscope slide vouchers (20% or 40% Karo™ corn syrup, 1% aniline blue in 1N HCl in a ratio of 20:1:1) are deposited in Herbarium/C. W. Schneider at Trinity College. The *P.B.-A.* set utilized in the present study was originally purchased by Wellesley College (Fahey and Doty 1955) and is presently located in the Herbarium/C. W. Schneider. Standard forms of author names follow Brummitt and Powell (1992). Because other works (e.g., Blum 1972; Entwisle 1988a) include world distributions for the species found in Connecticut and are often not specific for a particular place, citing "widespread in North America," we have listed states and provinces in the northeastern part of North America with known reports under the designation "NORTHEAST DISTRIBUTION."

RESULTS AND DISCUSSION

Few samples collected were fertile in the field. The remainder of the collections with obvious *Vaucheria* siphons later produced gametangia after 10–14 days in culture, on the average. About 30% of the mud samples never produced *Vaucheria* after incubation in culture media. In others without obvious *Vaucheria*, either siphons existed within the mud below grade, or dormant zygotes or asexual spores were coaxed into germinating under favorable culture/incubator conditions. Many cultures produced two to six biotic sympatric species over time in a single crude sample. Most species discovered in this study presented unremarkable features from those reported for other North American populations, so the reader is referred to Blum (1972) for full descriptions including pertinent measurements. Where our observations have been at variance with Blum (1972), these are noted below. We have discovered great variability in our extensive collections, allowing for a greater understanding of the species and overlap among them. Thus, when working with the polymorphic *Vaucheria*, it is advisable to sample widely for species and to rely on measurements and morphological characteristics of many individuals before making taxonomic determinations.

Although we have sampled extensively throughout the state, we have the fewest *Vaucheria* species records (four) from the northwestern Litchfield Co. This is in part due to more limited sampling there (14 sites), but mostly because of the poor, often sandy, substrata found in this part of the state. New records for Connecticut are noted with asterisks (*).

VAUCHERIACEAE Dumortier 1822, p. 71

Vaucheria aversa Hassal 1843, p. 429. Figures 1–3, 46.

TYPE LOCALITY: vic. Chestnut, England.

NORTHEAST DISTRIBUTION: Maine, N.H., Mass., Conn., N.Y., N.J.

REPRESENTATIVE COLLECTIONS: Fairfield Co.—**KP1**, *CEL*, coll. 25.x.1998, gam. 1.xi.1998; **NR2**, *CEL*, coll. 28.xi.1997, gam. 7.ii.1998; **PB1**, *CEL*, coll. 28.xi.1997, gam. 6.i.1998; **PN1**, *CEL*, coll. 31.v.1998, gam. 6.vi.1998; **SNR1**, *CEL*, coll. 25.x.1998, gam. 1.xi.1998. Hartford Co.—**BBB2**, *CWS*, coll. 10.xii.1997, gam. 6.i.1998; **BRWB**, *CWS*, coll. 12.xii.1997, gam. 23.v.1998; **CP1**, *AN*, coll. 22.ii.1998, gam. 23.v.1998; **EGST**, *CWS*, coll. 12.xii.1997, gam. 3.iii.1998; **GMS1**, *CEL/CWS*, coll. 5.vi.1998, gam. 14.vi.1998; **GRDD1**, *AN*, coll. 22.ii.1998, gam. 22.iv.1998; **JB1**, *AN*, coll. 22.ii.1998, gam. 28.v.1998; **LJB1**, *AN*, coll. 22.ii.1998, gam. 28.v.1998; **PGB1**, *CEL*, coll. 10.x.1997, gam. 22.iv.1998; **SBBB1**, *CEL*, coll. 21.x.1997, gam. 29.xi.1997; **SCR1**, *CEL/CWS*, coll. 5.vi.1998, gam. 31.ix.1998. Middlesex Co.—**SR2**, *CWS*, coll. 28.ix.1997, gam. 23.xii.1997. New Haven Co.—**DLF1**, *AN/CEL*, coll. 15.xi.1997, gam. 13.i.1998; **EMR1**, *AN/CEL*, coll. 3.xii.1997, gam. 3.iii.1998. New London Co.—**AR1**, *CEL*, coll. 23.v.1998, gam. 7.vii.1998; **BBS1**, *CWS*, coll. 29.xi.1997, gam. 3.ii.1998; **LBM1**, *CWS*, coll. 29.xi.1997, gam. 13.i.1998; **LEL1**, *CWS*, coll. 29.xi.1997, gam. 10.iii.1998; **ST1**, *CEL*, coll. 23.v.1998, gam. in field. Tolland Co.—**AB1**, *CWS/AN*, coll. 12.iii.1998, gam. 25.v.1998; **CB1**, *CEL*, coll. 30.vii.1998, gam. 10.x.1998; **SKR1**, *CEL*, coll. 11.xi.1997, gam. 12.i.1998. Windham Co.—**NK1**, *AN/CWS*, coll. 18.ix.1997, gam. 21.v.1998; **NK7**, *MED/CWS*, coll. 29.ix.1998, gam. 22.x.1998; **QR1**, *CEL*, coll. 20.viii.1998, gam. 31.ix.1998.

REMARKS. *Vaucheria aversa* was first reported for Connecticut in *P.B.-A.* by Collins et al. (1898) and later by Hylander (1925, 1928). Blum (1972) reported this species in eastern and mid-western United States and Alaska. We have found *V. aversa* throughout Connecticut (Figure 46) in river beds, drainage ditches, and woodland trails—this species appeared in 20% of our crude cultures. Often, samples containing this species did not appear as fertile siphons until two or more months in culture. In a few instances, after being in culture for up to 3 months, *V. aversa* became the dominant species in the crude samples, excluding others.

Vaucheria aversa is one of two species in Connecticut, along with *V. bursata*, with sessile gametangia. These two can be easily distinguished by the angle and appearance of oogonia and by antheridial morphology. Oogonia of *V. bursata* have completelyfilled cavities at maturity and have beaks that are directed at 70–80° angles from the siphons towards the adjacent long, curled, cylindrical antheridia (Figures 4–8). The oogonia of *V. aversa* have peripheral cavities when mature and arise at 20–30° angles, with their beaks deflected downwards to the siphons in the vicinity of the adjacent short, straight, fusiform to cylindrical antheridia (Figures 1–3). Neither of these two could be confused with any other freshwater Connecticut species.

Vaucheria bursata (O. F. Müll.) C. Agardh 1811, p. 21.
Figures 4–8, 47.

BASIONYM: *Conferva bursata* O. F. Müll. 1788, p. 96.

TYPE LOCALITY: Geneva, Switzerland.

NORTHEAST DISTRIBUTION: Maine, Mass., R.I., Vt., Conn., N.J.

REPRESENTATIVE COLLECTIONS: Fairfield Co.—**CD1**, *CEL*, coll. 31.v.1998, gam. 28.vi.1998; **CPG1**, *CEL*, coll. 31.v.1998, gam. 6.vi.1998; **KP1**, *CEL*, coll. 25.x.1998, gam. 28.x.1998; **NB1**, *CEL*, coll. 28.xi.1997, gam. 12.i.1998; **NCM1**, *CEL*, coll. 25.x.1998, gam. in field; **MB1**, *CEL*, coll. 28.xi.1997, gam. 3.iii.1998; **PN1**, *CEL*, coll. 31.v.1998, gam. 6.vi.1998; **WMR1**, *CEL*, coll. 25.x.1998, gam. in field. Hartford Co.—**BBB1**, *CWS*, coll. 10.xii.1997, gam. 20.i.1998; **BRWB1**, *CWS*, coll. 12.xii.1997, gam. 27.v.1998; **BUR1**, *CWS/CEL*, coll. 5.vi.1998, gam. in field; **FTS1**, *CWS*, coll. 21.ix.1994, gam. 24.iv.1996; **GSB1**, *CWS*, coll. 12.xii.1997, gam. 3.ii.1998; **NH1**, *CEL*, coll. 8.x.1997, gam. 23.x.1997; **PGB1**, *CEL*, coll. 10.x.1997, gam. 17.x.1997; **RGB1**, *CEL/CWS*, coll. 5.vi.1998, gam. 14.vi.1998; **RP2**, *AN*, coll. 13.xi.1997, gam. 29.xi.1997; **TMR1**, *AN/CEL*, coll. 1.x.1997, gam. 14.x.1997; **WBB1**, *CWS*, coll. 10.xii.1997, gam. 25.v.1998; **WHR1**, *AN*, coll. 13.xi.1997, gam. 2.xii.1997; **WPF2**, *AN*, coll. 7.x.1997, gam. 31.x.1997. Litchfield Co.—**BBR1**, *CEL*, coll. 30.vii.1998, gam. 3.ix.1998; **BNB1**, *CEL*, coll. 1.ix.1998, gam. 29.ix.1998; **EA1**, *CEL*, coll. 1.ix.1998, gam. in field; **HOR2**, *CEL*, coll. 30.vii.1998, gam. 21.ix.1998; **KFB1**, *CEL*, coll. 30.vii.1998, gam. 12.xi.1998; **NCWR1**, *CEL*, coll. 30.vii.1998, gam. 23.ix.1998. New London Co.—**LBM1**, *CWS*, coll. 29.xi.1997, gam. 24.vi.1998; **ST1**, *CEL*, coll. 23.v.1998, gam. in field; **TR2**, *AN/CEL*, coll. 22.x.1997, gam. 1.xi.1997. Tolland Co.—**SKR2**, *CEL*, coll. 23.v.1998, gam. 9.ix.1998.

REMARKS. *Vaucheria bursata* was first reported in Connecticut as *V. sessilis* (Vaucher) DC (Lamarck and de Candolle 1805) by Hylander (1928) and Brown (1929). *Vaucheria sessilis* was shown by Christensen (1973) to be a junior synonym of *V. bursata*, based upon Müller's (1788) illustrations of *Conferva bursata*, as well as collections Christensen made at Bad Meinberg, southwest of Hanover, Germany. Blum (1972) maintained *V. ses-*

silis and two similar species, *V. repens* Hassall and *V. clavata* sensu Klebs, differentiating each by siphon diameter and number of oogonia in association with each antheridium. Based upon our collections of *V. bursata* from a variety of habitats in Connecticut, we find these distinctions untenable, and follow Entwisle (1987, 1988a) in considering these as heterotypic synonyms of *V. bursata*. For example, we have found individual siphons with one and two oogonia associated with an antheridium. Our collections of this cosmopolitan freshwater species come from all but two counties in the state, Middlesex and Windham (Figure 47). *Vaucheria bursata* appeared in 20% of our crudes cultures, thus being one of the most commonly encountered species in the state.

Vaucheria compacta var. *compacta* (Collins) Collins ex W. R. Taylor 1937, p. 226. Figures 9–11, 48.

BASIONYM: *Vaucheria piloboloides* var. *compacta* Collins 1900, p. 13.

TYPE LOCALITY: Malden Mass., United States.

NORTHEAST DISTRIBUTION (freshwater only): Conn.

COLLECTIONS: Fairfield Co.—**CD1**, *CEL*, coll. 31.v.1998, gam. 6.vi.1998; **BPG1**, *CEL*, coll. 31.v.1998, gam. 6.vi.1998.

REMARKS. This species is widespread in New England saltmarshes (Blum and Conover 1953) and was first reported in Connecticut as *Vaucheria piloboloides* by Collins (1900). In our study of brackish and saltwater species in Connecticut, we commonly found *V. compacta* throughout the northern coast of Long Island Sound (Schneider et al. 1993). In cultures from these coastal areas, we found *V. compacta* growing and fertile from 0.3–30‰ salinity. This species is only known from very low salinity *in situ* brackish water in Louisiana (2.2‰; Pecora 1977), and elsewhere can be found in supersaline environments (Christensen 1987, 1988; Simons 1974). Our "freshwater" collections of *V. compacta* from Greenwich (Figure 48) are from two sites where the *in situ* salinity was 1‰ and 2‰, comparable to the levels recorded for this species in Louisiana (Pecora 1977)—sites where *V. undulata* and *V. bursata*, two other freshwater species, were found. These are the first low-salinity collections from the northeast other than the records of its freshwater variety, *V. compacta* var. *dulcis* (see below).

Vaucheria compacta is dioecious. After a month in freshwater culture, both samples produced male gametangia only in the 16L/8D photoperiod regime, with the samples in 8L/16D and 12L/12D remaining vegetative. The antheridia were mostly of the typical "brackish-type," with two or more lateral discharge pores (Figures 9, 10), not to be confused with those produced by *V. compacta* var. *dulcis* that have one or no lateral discharge pores (Figures 12, 13) (Schneider et al. 1996; Simons 1974). In both Greenwich samples, the siphons produced male gametangia for less than two weeks. Thereafter the cultures became overgrown by other freshwater algal species including *Vaucheria*.

Vaucheria compacta var. *dulcis* J. Simons 1974, p. 624.
Figures 12, 13, 49.

TYPE LOCALITY: The Netherlands.
NORTHEAST DISTRIBUTION: Conn., Delaware.

REPRESENTATIVE COLLECTIONS: Hartford Co.—**RPC**, *CWS*, coll. 8.x.1992, gam. 21.x.1992; **FW**, *CWS*, coll. 8.x.1992, gam. 26.x.1992; **FP2**, *CEL/CWS*, coll. 5.vi.1998, gam. 24.vi.1998.

REMARKS. Despite our extensive collections of *Vaucheria* in the state during all seasons over two years, we have not located this freshwater variety of *V. compacta* in locations outside those in the original report for North America of dense year-round populations in the Connecticut and Farmington Rivers below the Rainbow Dam (Figure 49; Schneider et al. 1996). These populations remain present and abundant only in areas of the Farmington River where they receive daily "hydrotidal" flooding from the twice-daily hydroelectrical generation produced by the dam, as well as natural tidal effects from Long Island Sound in the Connecticut River. Schneider et al. (1996) speculated that the variety's exclusive distribution in Connecticut would be only to areas receiving daily freshwater tidal flushing and this has been borne out by a lack of collections from sites other than those in the original report. We cannot speculate why this variety hasn't found its way to the lower Housatonic and Thames River systems, as both are affected by tidal waters. In the Farmington River, *V. compacta* var. *dulcis* thrives as thick continuous mat-like bands, especially along the banks with the greatest flow of water, and unlike other *Vaucheria* species in the state, it seems to grow to the exclusion of other species (Schneider et al. 1996).

Despite years of culture work and field collections, we have yet to find or produce oogonia on plants from these sites, though antheridia have been abundant (Schneider et al. 1996). Nevertheless, differences in the antheridial morphology allowed us to differentiate this European variety from the nominate species, *Vaucheria compacta*. The freshwater variety maintains its distinctive antheridial characteristics despite drastic salinity changes *in vitro* (Schneider et al. 1996).

Vaucheria frigida (Roth) C. Agardh 1824, p. 173.
Figures 14–19, 50.

BASIONYM: *Conferva frigida* Roth 1797, p. 166.

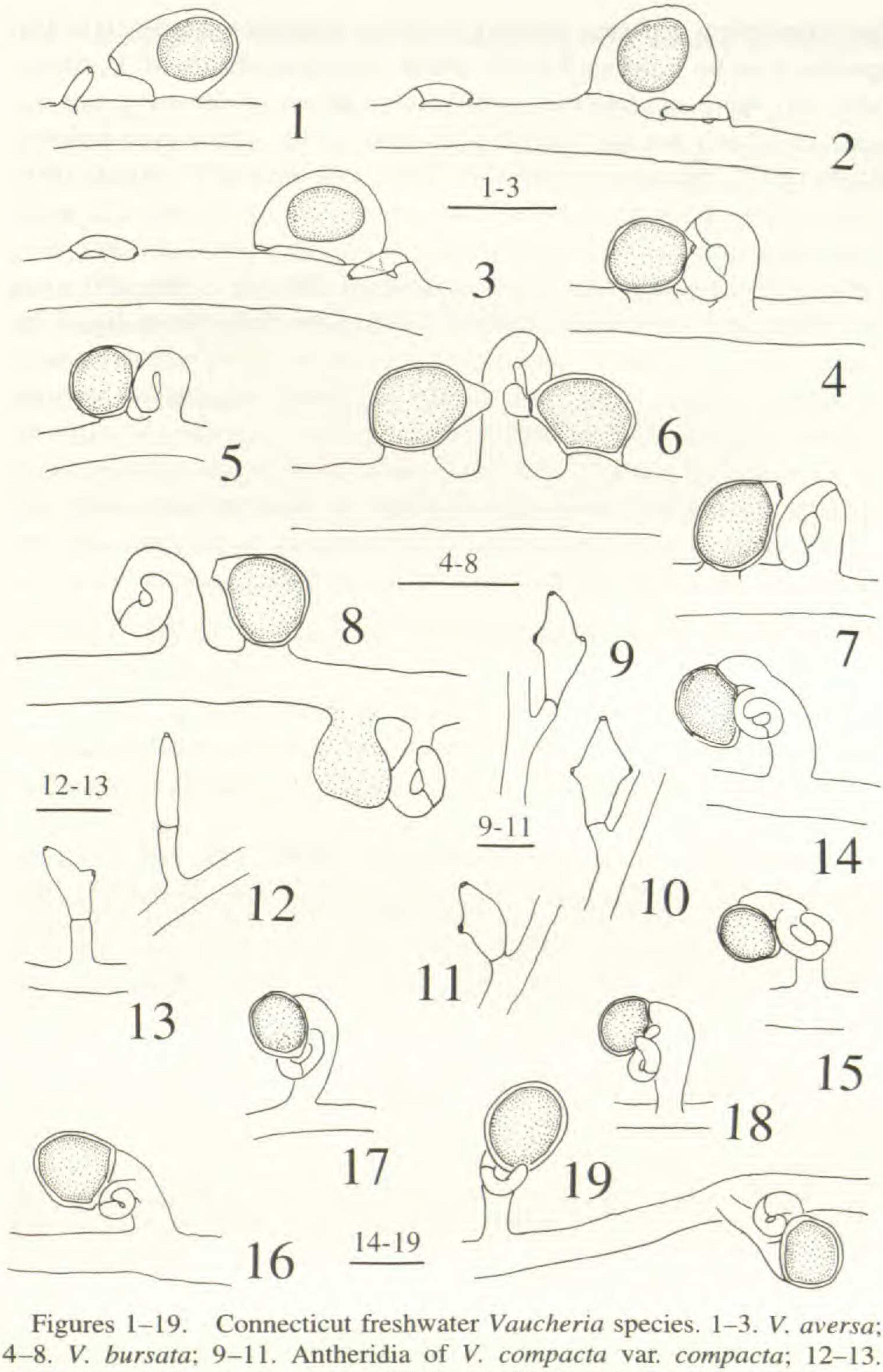
TYPE LOCALITY: London, England.

NORTHEAST DISTRIBUTION: N.B., Maine, Mass., R.I., Conn., N.Y.

REPRESENTATIVE COLLECTIONS: Fairfield Co.—**CPG1**, *CEL*, coll. 31.v.1998, gam. 12.xi.1998; **MB1**, *CEL*, coll. 28.xi.1997, gam. 3.ii.1998; **NR2**, *CEL*, coll. 28.xi.1997, gam. 6.xii.1997; **PB1**, *CEL*, coll. 28.xi.1997, gam. 6.i.1998. Hartford Co.—**BBB2**, *CWS*, coll. 10.xii.1997, gam. 6.i.1998; **BUR1**, *CWS/CEL*, coll. 5.vi.1998, gam. 2.vii.1998; **FS1**, *CWS*, coll. 5.ix.1995, gam. 10.x.1995; **JB1**, *AN*, coll. 22.ii.1998, gam. 28.v.1998; **RGB2**, *CEL/CWS*, coll. 5.vi.1998, gam. 17.vii.1998; **WP2**, *AN*, coll. 7.x.1997, gam. 29.xi.1997. New London Co.—**SDD1**, *CWS*, coll. 29.xi.1997, gam. 3.i.1998. Tolland Co.—**RRB1**, *CEL*, coll. 6.xi.1997, gam. 25.v.1998. Windham Co.—**LR1**, *CEL*, coll. 20.viii.1998, gam. 12.xi.1998; **NK3**, *AN/CWS*, coll. 18.ix.1997, gam. 29.xi.1997.

REMARKS. For much of its taxonomic history, *Vaucheria frigida* was confused with another species originally described from Europe, *V. terrestris* (Vaucher) DC (Christensen 1968). Early North American collectors apparently followed the account of *V. terrestris* by Götz (1897), a taxon now considered distinct from true *V. terrestris* (Blum 1972; Christensen 1968). Thus, early collections of *V. frigida* from Connecticut were reported as *V. terrestris* (Blum 1953; Brown 1929; Hylander 1925, 1928), as well as distributed in the *P.B.-A.* exsiccata (Collins et al. 1895, no. 78a). *Vaucheria frigida* occurs throughout North America, as well as being cosmopolitan elsewhere, while *V. terrestris* is presently recognized only from Europe (Blum 1972). We have collected *V. frigida* in all seven Connecticut counties, and it appeared in 13% of our cultures (Figure 50).

In *Vaucheria frigida*, thick-walled oogonia are borne singly on fruiting branches distal to single circinate antheridia. Long axes of oogonia are projected either horizontally or directed back at



Figures 1–19. Connecticut freshwater *Vaucheria* species. 1–3. *V. aversa*; 4–8. *V. bursata*; 9–11. Antheridia of *V. compacta* var. *compacta*; 12–13. Antheridia of *V. compacta* var. *dulcis*; 14–19. *V. frigida*. All scale bars = 100 μm.

the supporting siphons bearing fruiting branches (pedicels). The species can be confused with single oogonial forms of *V. undulata*, but there are obvious differences between the two, not the least of which are the spiraled siphons of the latter (see below). Blum (1972) found considerably larger oogonia in *V. frigida* (80–135 × 106–165 μm) than in *V. undulata* (71–113 × 96–127 μm). Our collections as well yielded larger oogonia for *V. frigida* (81–110 × 93–140 μm) than for *V. undulata* (50–80 × 60–100 μm), but these had somewhat smaller dimensions than those listed by Blum (1972). While *V. undulata* often bears reproductive branches with a single oogonium, rarely are there vegetative siphons without reproductive branches bearing two oogonia. As siphons of *V. undulata* mature and bear more gametangia, the pedicels usually proliferate from one another, a phenomenon only observed once in eighteen fertile collections of *V. frigida*, and not nearly to the extent of that seen in *V. undulata* (see below).

Vaucheria geminata (Vaucher) DC in Lamarck et DC 1805, p. 62. Figures 20–22, 51.

BASIONYM: *Ectosperma geminata* Vaucher 1803, p. 29.

TYPE LOCALITY: Between Geneva and Versoix, Switzerland.

NORTHEAST DISTRIBUTION: Maine, N.H., Vt., Mass., Conn., N.J.

REPRESENTATIVE COLLECTIONS: Fairfield Co.—**BSP1**, *CEL*, coll. 31.v.1998, gam. 6.vi.1998; **BUR1**, *CEL/CWS*, coll. 5.v.1998, gam. 28.vi.1998; **NB1**, *CEL*, coll. 28.xi.1997, gam. 25.v.1998; **PB1**, *CEL*, coll. 28.xi.1997, gam. 22.iv.1998. Hartford Co.—**EGST**, *CWS*, coll. 12.xii.1997, gam. 3.ii.1998; **GMS1**, *CEL/CWS*, coll. 5.vi.1998, gam. 14.vi.1998; **LJB1**, *AN*, coll. 22.ii.1998, gam. 14.iv.1998; **LV1**, *CEL*, coll. 21.x.1997, gam. 29.xi.1997; **NBBB1**, *CWS*, coll. 8.xi.1997, gam. 3.i.1998; **NH1**, *CEL*, coll. 8.x.1997, gam. 23.x.1997; **QP1**, *AN/CEL*, coll. 1.x.1997, gam. 22.iv.1998; **SCR1**, *CEL/CWS*, coll. 5.vi.1998, gam. 14.vi.1998; **WHR1**, *AN*, coll. 13.xi.1997, gam. 2.xii.1997. Litchfield Co.—**HOR2**, *CEL*, coll. 30.vii.1998, gam. 20.xi.1998. Middlesex Co.—**SR2**, *CWS*, coll. 28.ix.1997, gam. 11.x.1997. New London Co.—**CCR1**, *CEL*, coll. 23.v.1998, gam. 6.vi.1998; **LBM1**, *CWS*, coll. 29.ix.1997, gam. 16.ii.1998; **SDD1**, *CWS*, coll. 29.ix.1997, gam. 22.iv.1998; **ST1**, *CEL*, coll. 23.v.1998, gam. 14.vi.1998. Windham Co.—**NK3**, *AN/CWS*, coll. 18.ix.1997, gam. 15.x.1997.

REMARKS. Collins et al. (1905) first reported *Vaucheria geminata* from Connecticut, followed by the reports of Hylander (1925, 1928), and in this study it was collected in 18% of our samples from throughout the state (Figure 51).

Vaucheria geminata almost invariably produces two opposite oogonia on short to slightly extended pegs off erect reproductive branches at abaxial angles of 50–70° (Figures 21, 22). In a few instances, we found reproductive branch proliferation (Figure 20), a phenomenon also noted by Christensen (1969; fig. 9837a, i) for *V. geminata*. The oogonia are ovoid to slightly reniform in shape (Figures 20–22) and range from 60–78 × 62–90 μm. Circinate antheridia are borne singly and terminally in between and distal to the oogonia, but mostly not projecting beyond the height of the oogonia (Figures 20–22). Fertile *V. geminata* appear very similar to forms of *V. taylorii* that bear two oogonia on reproductive branches (see below), with the distinguishing characters of not-overly-swollen pedicels (often distinctly swollen in *V. taylorii*) and the height of antheridia (*V. taylorii* mostly has its antheridia exceeding the tops of the oogonia on pedicels). Oogonia are often distinctly flattened on adaxial surfaces in *V. taylorii* (see below), a characteristic not seen in *V. geminata*. As discussed later in this report, the Connecticut specimens of *V. geminata* and its var. *racemosa* distributed in *P.B.-A.* (XXVI:1287), are now seen to be a polymorphic collection of *V. taylorii*.

**Vaucheria prona* T. A. Chr. 1970, p. 250. Figures 23–27, 52.
TYPE LOCALITY: Kongelunden, Amager, Denmark.
NORTHEAST DISTRIBUTION: Mass., Conn., N.Y.

REPRESENTATIVE COLLECTIONS: Fairfield Co.—**BSP1**, *CEL*, coll. 31.v.1998, gam. 6.vi.1998; **NR2**, *CEL*, coll. 28.ix.1997, gam. 6.xii.1997; **PB1**, *CEL*, coll. 28.ix.1997, gam. 22.iv.1998; **SNR1**, *CEL*, coll. 25.x.1998, gam. in field. Hartford Co.—**BBB1**, *CWS*, coll. 10.xii.1997, gam. 2.iii.1998; **CP1**, *AN*, coll. 22.ii.1998, gam. 3.xi.1998; **GRDD1**, *AN*, coll. 22.ii.1998, gam. 22.iv.1998; **HLM**, *CWS*, coll. 23.xi.1998, gam. in field; **JB1**, *AN*, coll. 22.ii.1998, gam. 28.v.1998; **LV1**, *CEL*, coll. 21.x.1997, gam. 3.xi.1997; **PGB1**, *CEL*, coll. 10.x.1997, gam. 21.v.1998; **PBW**, *CWS*, coll. 5.xii.1997, gam. 3.i.1998; **QP1**, *AN/CEL*, coll. 1.x.1997, gam. 1.x.1997; **SBBB1**, *CEL*, coll. 21.x.1997, gam. 20.xi.1997; **TMR1**, *AN/CEL*, coll. 1.x.1997, gam. 13.x.1997; **WCP1**, *AN*, coll. 22.ii.1998, gam. 14.iv.1998. New London Co.—**BBS1**, *CWS*, coll. 29.xi.1997, gam. 3.ii.1998; **RRD1**, *AN/CEL*, coll. 22.x.1997, gam. 11.ix.1997; **TR1**, *AN/CEL*, coll. 22.x.1997, gam. 28.x.1997. Tolland Co.—**SKR2**, *CEL*, coll. 23.v.1998, gam. 28.vi.1998. Windham Co.—**NK3**, *AN/CEL*, coll. 18.ix.1997, gam. 29.xi.1997.

REMARKS. Previously encompassed under *Vaucheria terrestris* (Vaucher) DC (=*V. frigida*), Christensen (1970) separated *V. prona* from it, as the former had only a single pendent oogonium on a fertile branch. He noted that his paired, pendent oogonial plants actually represented what was later called *V. hamata* sensu Götz (1897). In order to avoid continued taxonomic confusion, *V. prona* was established as a new species to accomodate this paired oogonial alga rather than reintroducing new concepts for long-established taxa (Christensen 1970). This common alga was designated by early North American workers as *V. hamata*, and is now recognized from collections from throughout the world (Entwisle 1988a). Our isolates of *V. prona* represent the first records of this species from Connecticut, and only the second from New England. This species was found in 16% of our samples, but not in Litchfield, New Haven, and Middlesex counties (Figure 52).

Oogonia on *Vaucheria prona*, like those of *V. frigida*, are formed distally to single antheridia on fertile branches, and are pendent on downwardly curved pegs off curved fertile branches. In some cultures, gametangia were formed terminally on the siphons themselves or on greatly extended fruiting branches. In *V. prona* there are usually two large oogonia (42–68 × 55–78 μm) found on each fruiting branch, and when fully mature have opositional tips (Figures 24, 26). Occasionally, we have found fruiting branches proliferating from others, while retaining two oogonia on the basal fruiting branch. Such occurrences are not nearly as common as those in *V. undulata*, a species that normally retains only a single oogonium on the basal branch. At one site (**HLM**), we often found *V. prona* producing three or four oogonia per pedicel (Figure 23), and in rare instances, we have found siphons producing only a single oogonium on a fertile branch (Figure 25). The multiple oogonial form is easily distinguished from *V. taylorii* by its pendent oogonia, a phenonmenon also nicely illustrated in Australian populations of this species (Entwisle 1988a; figs 85, 90). However, the single oogonial form of *V. prona* is difficult to distinguish from the single forms of *V. frigida* and *V. undulata*. Careful observations of large populations of *V. frigida* and *V. prona* allow for the separation of the single from paired oogonial species, as the presence of two oogonia in *V. frigida* or one in *V. prona* are infrequent at best. *Vaucheria prona* can be confused with *V. undulata* when the latter species is immature, producing oppositely paired oogonia on reproductive branches. *Vaucheria undulata*, however, has trademark spiraled siphons (Figure 39) and, at maturity, consistently produces proliferating pedicels from the sites where one oogonium in an opposite pair would have formed on a reproductive branch (see below). *Vaucheria prona* can be distinguished from the other local species with opposite oogonia, *V. geminata*, as this species has erect oogonia on straight reproductive branches (Figures 20–22; Entwisle 1988b).

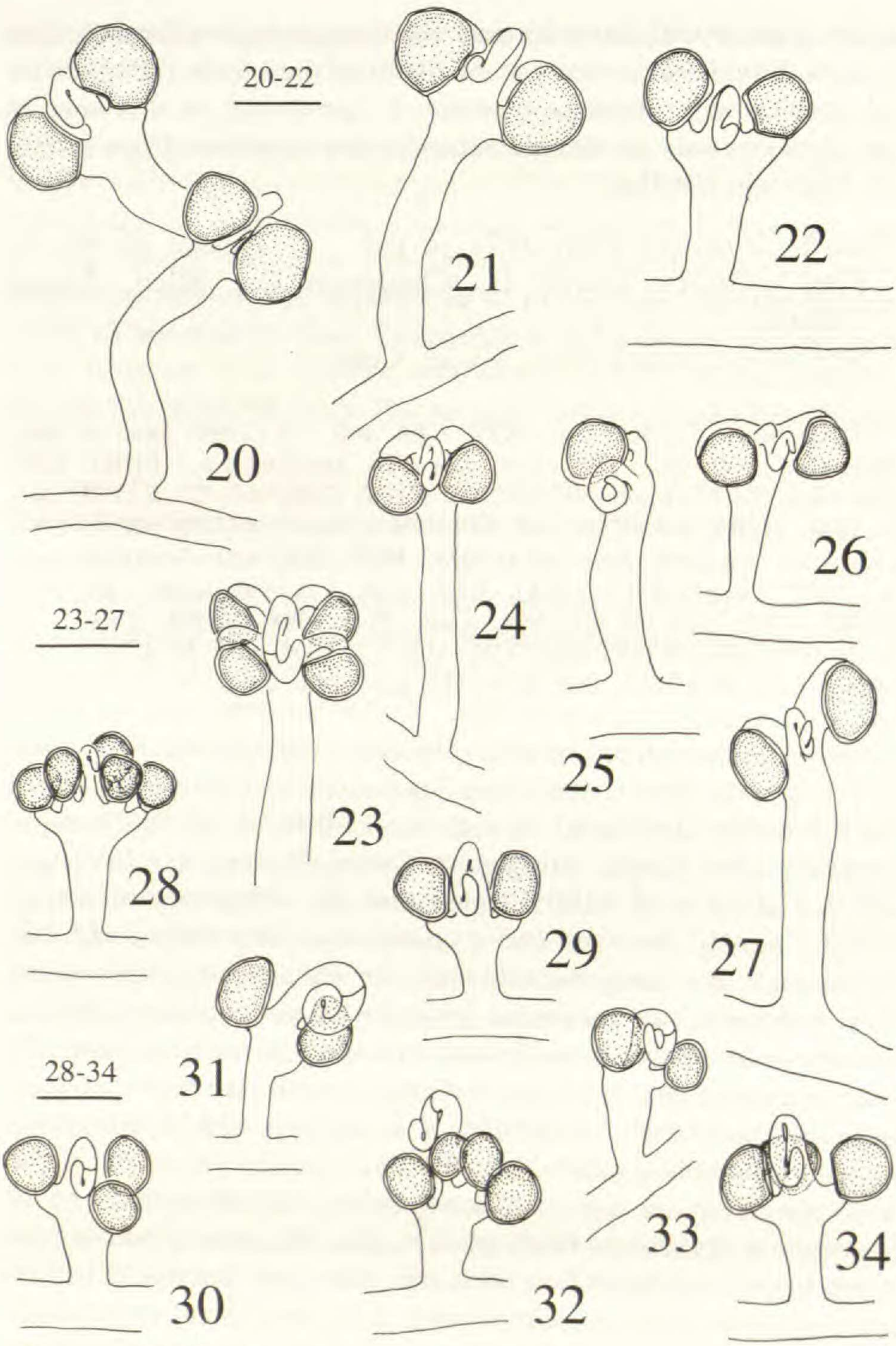
**Vaucheria taylorii* Blum 1971, p. 191. Figures 28–34, 53.

TYPE LOCALITY: Beaver Is., Charlevoix Co., Mich., United States.

NORTHEAST DISTRIBUTION: Maine, Conn.

COLLECTIONS: Fairfield Co.—**KP1**, *CEL*, coll. 25.x.1998, gam. in field; **NB1**, *CEL*, coll. 28.xi.1997, gam. 12.i.1998. Hartford Co.—**BUR1**, *CEL/CWS*, coll. 5.v.1998, gam. 29.vii.1998; **FTS1**, *CWS*, coll. 21.ix.1994, gam. 5.x.1994; **GSB2**, *CWS/CEL*, coll. 5.vi.1998, gam. 11.ix.1998; **NRS1**, *CWS/CEL*, coll. 5.x.1998, gam. 30.xi.1998; **WP1**, *AN*, coll. 7.x.1997, gam. 14.x.1997. Litchfield Co.—**EA1**, *CEL*, coll. 1.ix.1998, gam. 24.x.1998; **HOR2**, *CEL*, coll. 30.viii.1998, gam. 21.ix.1998; **KFB1**, *CEL*, coll. 30.viii.1998, gam. in field; **NN1**, *CEL*, coll. 1.ix.1998, gam. 21.ix.1998. New London Co.—**ST1**, *CEL*, coll. 23.v.1998, gam. 14.vi.1998.

REMARKS. Although our recent collections represent the first report of this species from Connecticut, specimens of *Vaucheria taylorii* were actually distributed in *P.B.-A.* (Collins et al. 1905) as *V. geminata* (Ash Creek, Bridgeport, Conn., *Holden* 9.iv.1892, no. 1287). Collins et al. (1905) noted that this dried specimen contained "mostly the type [of *V. geminata*], but with some var. *racemosa*," this being the sole basis for Hylander's (1928) report of *V. geminata* var. *racemosa* [=*V. racemosa* (Vaucher) DC], a species we have not found in our extensive collections here. We have examined this exsiccata and have established that specimen no. 1287 represents a collection of *V. taylorii* with 2–6 oogonia on fertile branches rather than the two species proposed in the exsiccata. Also, as will be shown below, the illustration of *V. geminata* in Hylander (1928; pl. XX, Fig. 8), could possibly represent *V. taylorii* depending upon the other reproductive branches that may have been associated with it in its original population. The oogonia of *V. taylorii* are borne at erect angles on pegs from the fruiting branches curving inwardly, often with their tips pointing towards terminal antheridia. *Vaucheria racemosa* can easily be distinguished by its downcurved, long pegs from fertile branches bearing pendent oogonia (Blum 1972). *Vaucheria racemosa* is in fact more similar to multiple oogonial forms of *V.*



Figures 20–34. Connecticut freshwater *Vaucheria* species. 20–22. *V. geminata*; 23–27. *V. prona*; 28–34. *V. taylorii*. All scale bars = 100 μm.

prona, but that species has long fruiting branches while those in *V. racemosa* are distinctly smaller (Blum 1972).

The antheridial pedicels of *Vaucheria taylorii* project at least to the same height as the tops of oogonia (Figures 28, 30), usually exceeding them and at times being significantly higher (Figures 32, 34), one of the characters used to distinguish it from *V. geminata* (Blum 1971). *Vaucheria taylorii* is further noted by its swollen pedicels (Blum 1971), yet this character is variable among and between the various collections we and others have made (Figures 28–34). Still, unlike *V. geminata*, some of the reproductive branches of *V. taylorii* in a population will be significantly swollen centrally where oogonial pegs are formed (Figures 28, 31, 32). Oogonia range from 61–91 × 64–92 μm, and show a trend from larger and distinctly flattened on adaxial surfaces when only two are formed on a reproductive branch (Figure 29), to smaller and ovate to reniform when present in whorls of three to six (Figures 28, 32).

The only other species we have found with more than two oogonia per fertile branch, *Vaucheria prona*, is easily distinguished by its markedly pendent oogonial pegs (Figure 23). Along with *V. compacta*, *V. taylorii* is one of the least prevalent freshwater species in Connecticut, appearing in only 8% of our collections (Figure 53).

**Vaucheria uncinata* Kütz. 1856, p. 21. Figures 35–38, 54.

Type locality: Freiburg, Germany.

Northeast distribution: Maine, N.H., Mass., Conn., N.Y.

Representative collections: Fairfield Co.—**SNR1**, *CEL*, coll. 25.x.1998, gam. in field; **NB1**, *CEL*, coll. 28.xi.1997, gam. 25.v.1998. Hartford Co.—**BBB2**, *CWS*, coll. 10.xii.1997, gam. 13.i.1998; **BUR1**, *CWS/CEL*, coll. 5.vi.1998, gam. 28.vi.1998; **CM1**, *CEL*, coll. 1.ix.1998, gam. 10.ix.1998; **FS3**, *CWS/CEL*, coll. 5.vi.1998, gam. 28.vi.1998; **GMS2**, *CWS/CEL*, coll. 5.vi.1998, gam. 28.vi.1998; **GRDD1**, *AN*, coll. 22.ii.1998, gam. 28.v.1998; **GSB2**, *CWS/CEL*, coll. 5.vi.1998, gam. 28.vi.1998; **RGB2**, *CWS/CEL*, coll. 5.vi.1998, gam. 28.vi.1998; **SCR1**, *CEL/CWS*, coll. 5.vi.1998, gam. 14.vi.1998. Litchfield Co.—**PTB1**, *CEL*, coll. 1.ix.1998, gam. 1.x.1998. Middlesex Co.—**SR2**, *CWS*, coll. 28.ix.1997, gam. 11.x.1997. New London Co.—**AR1**, *CEL*, coll. 23.v.1998, gam. 7.vii.1998; **CCR1**, *CEL*, coll. 23.v.1998, gam. 28.vi.1998; **HVP1**, *CEL*, coll. 23.v.1998, gam. 7.vii.1998; **LBM1**, *CWS*, coll. 29.xi.1997, gam. 24.vi.1998; **ST1**, *CEL*, coll. 23.v.1998, gam. 17.vii.1998; **TR1**, *AN/CEL*, coll. 22.x.1997, gam. 28.x.1997. Tolland Co.—**CB1**, *CEL*, coll. 11.ix.1997, gam. 3.ii.1998; **RRB1**, *CEL*, coll.

6.ix.1997, gam. 22.iv.1998. Windham Co.—**NK1**, *AN/CWS*, coll. 18.ix.1997, gam. 30.ix.1997; **NK7**, *MED/CWS*, coll. 29.ix.1998, gam. in field.

REMARKS. The complicated taxonomic and nomenclatural history of this species is summarized by Blum (1953). Our collections represent the first record of *Vaucheria uncinata* for Connecticut, although Blum (1972) reported its distribution throughout the continental United States. It is a somewhat common species in our collections, found in 15% of all sites sampled, occurring almost exclusively in the Connecticut River Valley or to the east of the Connecticut River (Figure 54). We rarely found *V. uncinata* on mud saturated with water in the field and it only appeared in our cultures when the crude samples became somewhat dried.

Vaucheria uncinata is easily distinguished from the other local species by its unusually large, transversely elongated, pendent oogonia (108–150 μm in greatest dimension) that often appear to be sessile on the siphons due to their terminal position on long, hooked, or gallows-shaped, reproductive branches (Figures 35–38). In certain locations during the fall, we have found fertile *V. uncinata* growing as an extensive mat over mud in non-flowing intermittent streams.

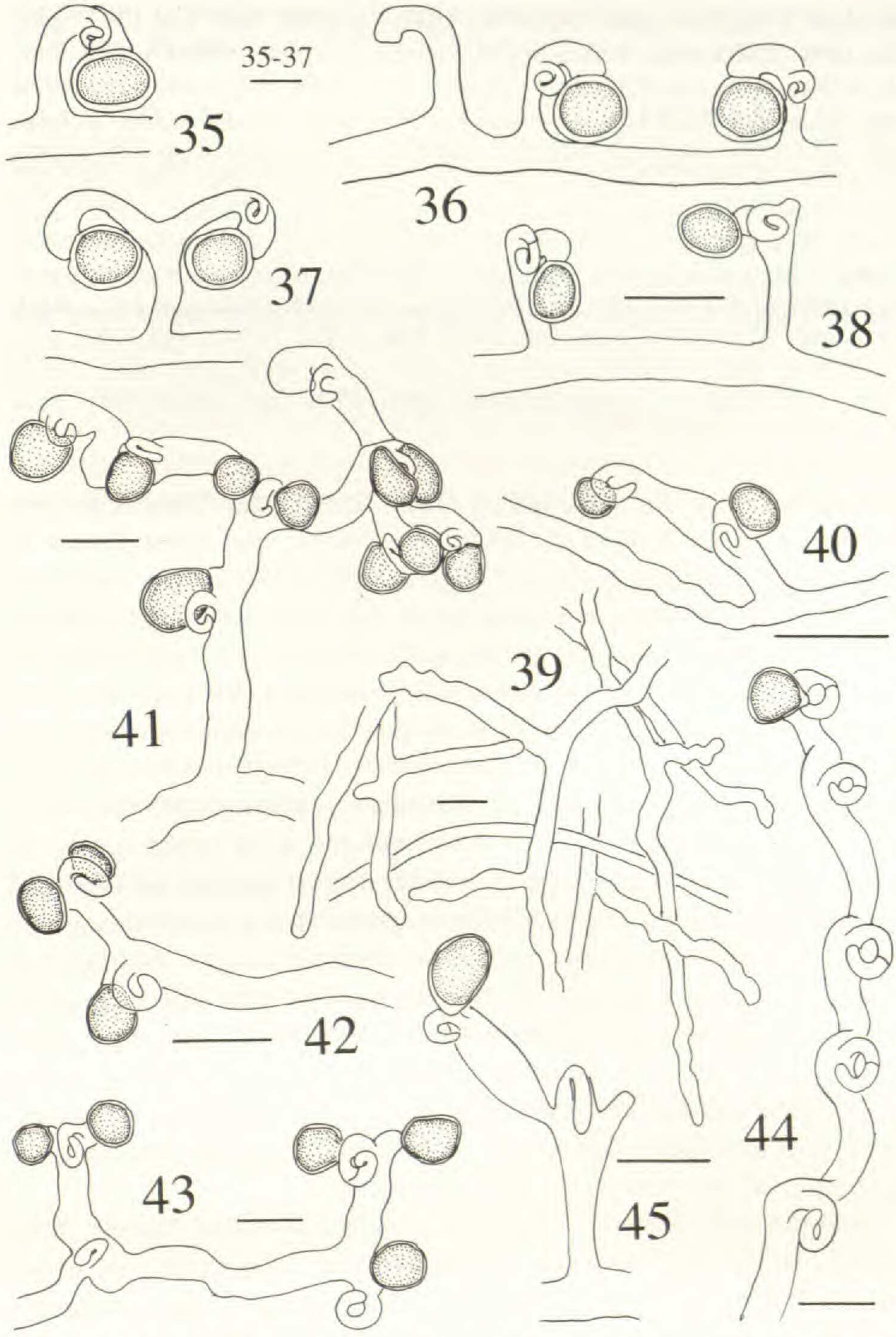
**Vaucheria undulata* C. C. Jao 1936, p. 741.

Figures 39–45, 55

TYPE LOCALITY: Fou-tu-Kuan, Szechwan, China.

NORTHEAST DISTRIBUTION: Maine, Mass., Conn., R.I., N.Y., N.J.

REPRESENTATIVE COLLECTIONS: Fairfield Co.—**AC1**, *CEL*, coll. 30.viii.1998, gam. 18.ix.1998; **BSP1**, *CEL*, coll. 31.v.1998, gam. 6.vi.1998; **CD1**, *CEL*, coll. 31.v.1998, gam. 14.vi.1998; **CPG1**, *CEL*, coll. 31.v.1998, gam. 6.vi.1998; **KP1**, *CEL*, coll. 25.x.1998, gam. in field; **NB1**, *CEL*, coll. 28.xi.1997, gam. 28.v.1998; **NCM1**, *CEL*, coll. 25.x.1998, gam. 12.xi.1998; **PB1**, *CEL*, coll. 28.xi.1997, gam. 17.vii.1998; **PN1**, *CEL*, coll. 31.v.1998, gam. 6.vi.1998; **SNR1**, *CEL*, coll. 25.x.1998, gam. in field. Hartford Co.—**BRWB**, *CWS*, coll. 12.xii.1997, gam. 23.v.1998; **CP1**, *AN*, coll. 22.ii.1998, gam. 3.ix.1998; **FMT1**, *CEL*, coll. 25.x.1998, gam. 12.xi.1998; **FWB1**, *CEL/CWS*, coll. 5.vi.1998, gam. 6.x.1998; **GMS1**, *CEL/CWS*, coll. 5.vi.1998, gam. 28.vi.1998; **GRDD1**, *AN*, coll. 22.ii.1998, gam. 30.v.1998; **MP1**, *CEL*, coll. 8.x.1997, gam. 15.x.1997; **RGB2**, *CEL/CWS*, coll. 5.vi.1998, gam. 14.vi.1998; **SBBB1**, *CEL*, coll. 21.x.1997, gam. 29.xi.1997; **SCR1**, *CEL/CWS*, coll. 5.vi.1998, gam. 14.vi.1998; **WCP1**, *AN*, coll. 22.ii.1998, gam. 28.v.1998. Litchfield Co.—**EA1**, *CEL*, coll. 1.ix.1998, gam. 21.ix.1998; **KFB1**, *CEL*, coll. 30.vii.1998, gam. 12.xi.1998; **PR2**, *CEL*, coll. 1.ix.1998, gam. in field; **PTB1**, *CEL*, coll. 1.ix.1998, gam. 23.ix.1998. Middlesex Co.—**SR2**, *CWS*, coll. 28.ix.1997, gam. 23.xii.1997. New Haven Co.—**DL1**, *CEL/*



Figures 35–45. Connecticut freshwater *Vaucheria* species. 35–38. *V. uncinata*; 39–45. *V. undulata*. All scale bars = 100 μm.

AN, coll. 3.xii.1997, gam. 3.ii.1998; **HB1**, *CEL/AN*, coll. 3.xi.1997, gam. 30.v.1998; **TSB1**, *CEL*, coll. 1.xi.1998, gam. 23.ix.1998; **WBSP1**, *CEL*, coll. 31.v.1998, gam. 9.ii.1999. New London Co.—**AR1**, *CEL*, coll. 23.v.1998, gam. 10.x.1998; **CCR1**, *CEL*, coll. 23.v.1998, gam. 6.vi.1998; **HVP1**, *CEL*, coll. 23.v.1998, gam. 17.vii.1998; **LBM1**, *CWS*, coll. 29.xi.1997, gam. 24.vi.1998; **TAB1**, *CEL*, coll. 23.v.1998, gam. 17.vii.1998; **TR1**, *CEL/AN*, coll. 22.x.1997, gam. 4.xii.1997. Tolland Co.—**CLB1**, *CEL*, coll. 20.viii.1998, gam. 24.x.1998; **MNE1**, *CWS*, coll. 12.iii.1998, gam. 6.vi.1998; **RRB1**, *CEL*, coll. 6.xi.1997, gam. 20.v.1998; **TD1**, *CWS*, coll. 5.x.1997, gam. 10.x.1997; **US1**, *CWS*, coll. 7.xii.1997, gam. 28.v.1998. Windham Co.—**BK1**, *CEL*, coll. 20.viii.1998, gam. 28.i.1999; **LR1**, *CEL*, coll. 20.viii.1998, gam. 12.xi.1998; **NK1**, *AN/CWS*, coll. 18.ix.1997, gam. 16.vi.1998; **NK7**, *MED/CWS*, coll. 29.ix.1998, gam. in field; **QR1**, *CEL*, coll. 20.viii.1998, gam. 10.ix.1998.

REMARKS. Since its description from Szechwan, *Vaucheria undulata*, with its trademark spiraled siphons, has been found in many New England locations (Blum 1972; Colt 1985), and here we add it to the flora of Connecticut. We have found this species to be widespread throughout the state (Figure 55), and it was the most prevalent species in our crude cultures (39%). In the past, *V. undulata* was undoubtedly misidentified as other species, collectors not recognizing it by the majority of siphons that develop spirally at the tips (Figure 39). However, if gametangia are found on a siphon lacking spiraled development, they could easily be confused with *V. frigida* or *V. prona*, due to similar gametangial morphology and position. All three species have pendent oogonia that are borne on fruiting branches distal to single circinate antheridia, *V. undulata* and *V. frigida* mostly with one oogonium per fruiting branch, *V. prona* usually with two. Unlike the others, *V. undulata* oospores often turn light brown prior to release from the mother siphon. Occasionally, *V. taylorii* produces a few undulating (spiraled?) siphons in a population, but the reproductive branches of the two species are distinct.

In his collections of *Vaucheria undulata* from Maine, Colt (1985) found that vegetative siphons were dimorphic, of either small (7–30 μm diam.) or large size (48–60 μm diam.), with few in the intermediate range. Furthermore, he noted that the smaller diameter axes were usually spiraled, while those of greater diameter were mostly undulate to subundulate. In our cultures, the filaments were found to be of a similar dimorphic range, with approximately 60% showing spiral development in both size classes. Our small-diameter siphons were distinctly spiraled, while the larger ones (mature?) were more swollen and appeared to be undulate. Furthermore, only the larger-sized siphons in our cultures produced gametangia. Oogonia in Connecticut populations ranged from 50–80 × 60–100 μm. The reproductive branches inevitably proliferated at maturity, a phenomenon seen only occasionally in other species such as *V. frigida, V. prona*, and *V. geminata* (Figure 20), but never to the extent of *V. undulata*. New reproductive branches were produced at the site where an opposite oogonium would have formed on the previous pedicel in the same system (Figures 40, 41, 43), often repeating this development sequentially (Figures 42, 44). In our crude cultures, *V. undulata* often grew to the exclusion of other *Vaucheria* species, the latter only appearing after the bloom of *V. undulata* had passed (5–6 weeks).

KEY TO THE FRESHWATER SPECIES OF *VAUCHERIA* IN CONNECTICUT

1. Antheridia and oogonia on separate plants (dioecious) 2
1. Antheridia and oogonia on the same plants (monoecious) ... 3
   2. Antheridia with 1 terminal and mostly 2 lateral discharge pores (Figures 9–11) .... *V. compacta* var. *compacta*
   2. Antheridia with 1 terminal and 1 or 0 lateral discharge pores (Figures 12, 13) ...... *V. compacta* var. *dulcis*
3. Oogonia and antheridia sessile or short-stalked on siphons, not borne on special bisexual fruiting branches (pedicels) ... 4
3. Oogonia and antheridia borne on special bisexual fruiting branches 5
   4. Oogonia formed singly or in pairs with long, circinate antheridia between them; oospores completely filling oogonial cavities at maturity; oogonial beaks oriented toward the antheridia, either parallel with the siphons or erect at oblique angles (Figures 4–8) ..... *V. bursata*
   4. Oogonia formed singly, never paired around a single antheridium, usually with small, cylindrical antheridia on both sides; oospores with obvious distal and peripheral oogonial cavities at maturity; oogonia with deflected beaks directed towards the siphons (Figures 1–3) .... *V. aversa*
5. Oogonia formed singly on fruiting branches 6
5. Oogonia usually 2 or more on each fruiting branch 7
   6. Oogonia subspherical to transversely elongate, lacking

beaks, pendent on hooked or gallows-shaped pedicels (Figures 35–38) .... *V. uncinata*

6. Oogonia subspherical to obovate and reniform with small distal beaks, borne terminally on curved pedicels (Figures 14–19) .... *V. frigida*

7. Population rarely containing spiraled siphons; oogonia almost always 2 per fruiting branch (occasionally 1 or 3–4, but these oogonia pendent), borne laterally to terminal erect antheridia; if proliferating additional fruiting branches, usually 2 oogonia maintained on the basal fruiting branch (Figure 20) 8

7. Population often containing spiraled siphons; oogonia highly variable in number per fruiting branch; if proliferating additional fruiting branches, usually 1 oogonium maintained on the basal fruiting branch (Figures 40–42) 9

8. Oogonia pendent on obvious downcurved pegs, occasionally numbering 3–4 (Figure 23); fruiting branches usually curved (Figures 24–27) .... *V. prona*

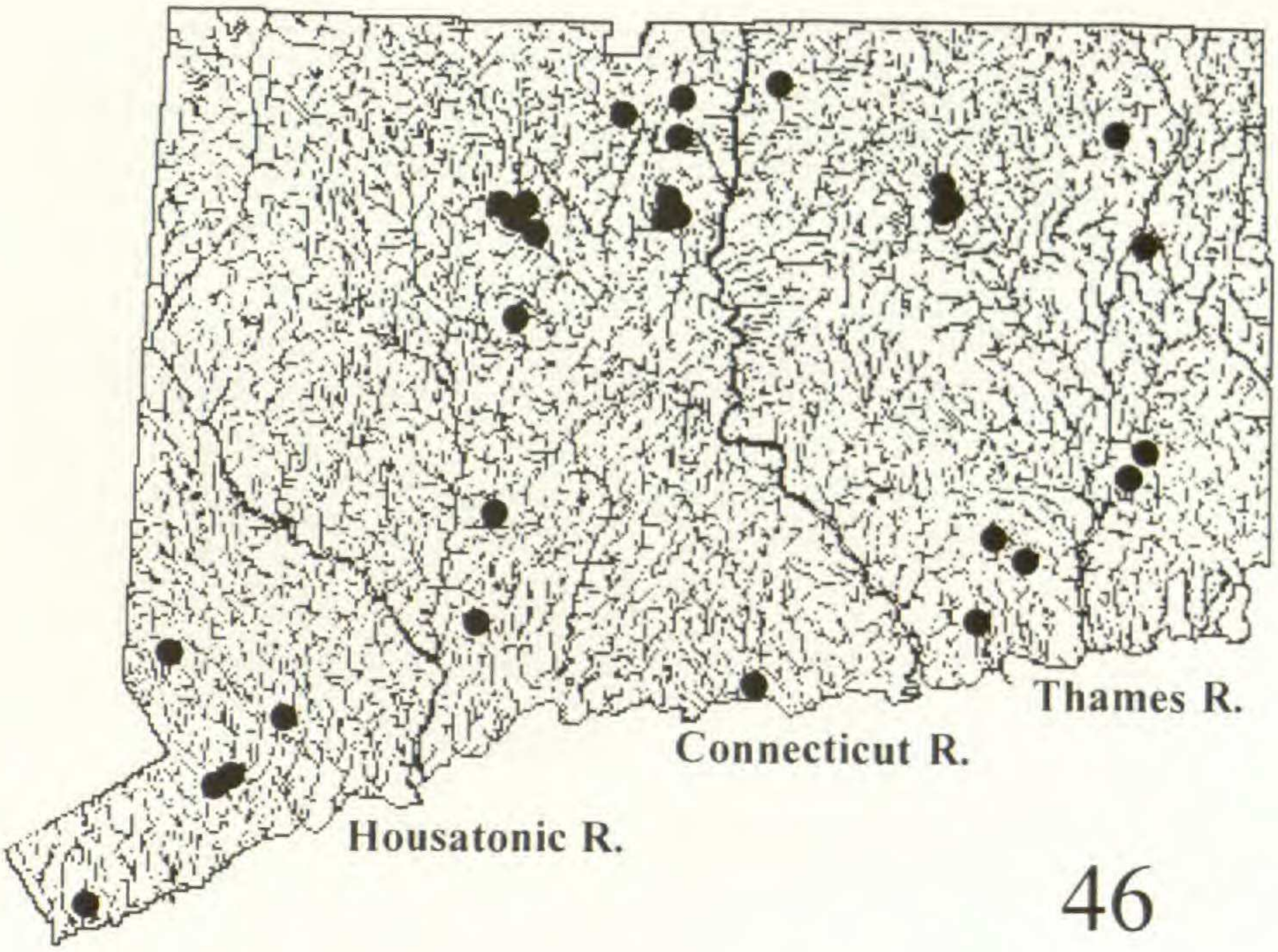
8. Oogonia erect on pegs and directed away from siphons, almost uniformly numbering 2; fruiting branches straight and erect (Figures 20–22) ..... *V. geminata*

9. Siphons commonly spiralling, especially the thinner ones in a population (Figure 39); oogonia 1 or 2 per fruiting branch, with variation common on individual siphons; fruiting branches commonly proliferating in chain-like fashion from one another at maturity (Figures 40–44); fruiting branches not swollen at points of oogonial attachment at maturity (Figures 41, 42) .... *V. undulata*

9. Siphons only occasionally spiralling; 2 to 6 oogonia per fruiting branch, with great variation common on individual siphons; fruiting branches distinctly swollen at points of oogonial attachment at maturity (Figures 28–34) ... . *V. taylorii*

ACKNOWLEDGMENTS. We thank Courtney Hadly, Megan Dunphy, Megan Garretson, and Ginny Schneider for their assistance on this project both in the field and in the lab. We acknowledge a Trinity College student research grant from the Faculty Research Committee to CEL. We appreciate the constructive criticism of the manuscript provided by Dr. Arthur Mathieson (UNH).

V. aversa



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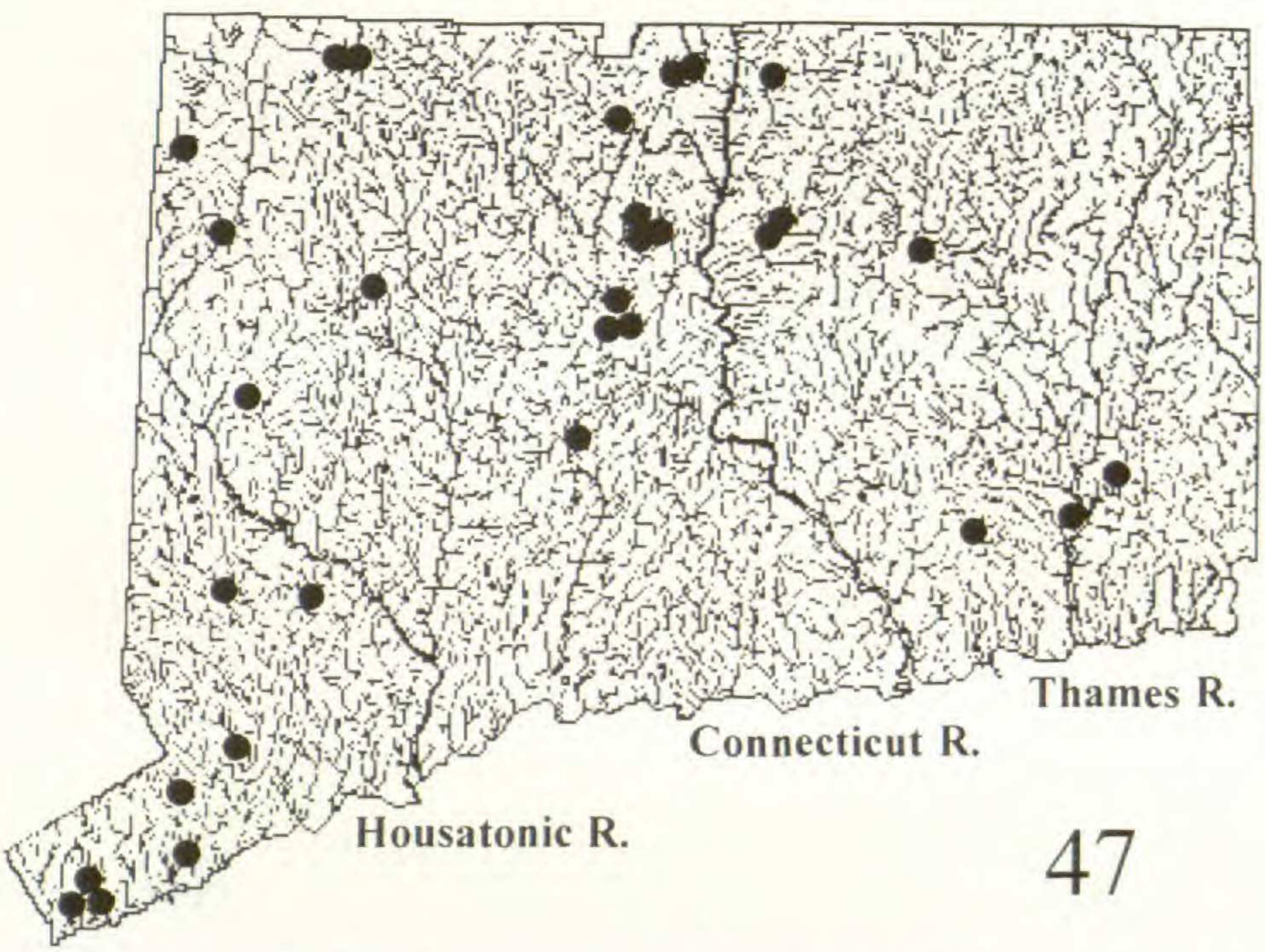
V. bursata



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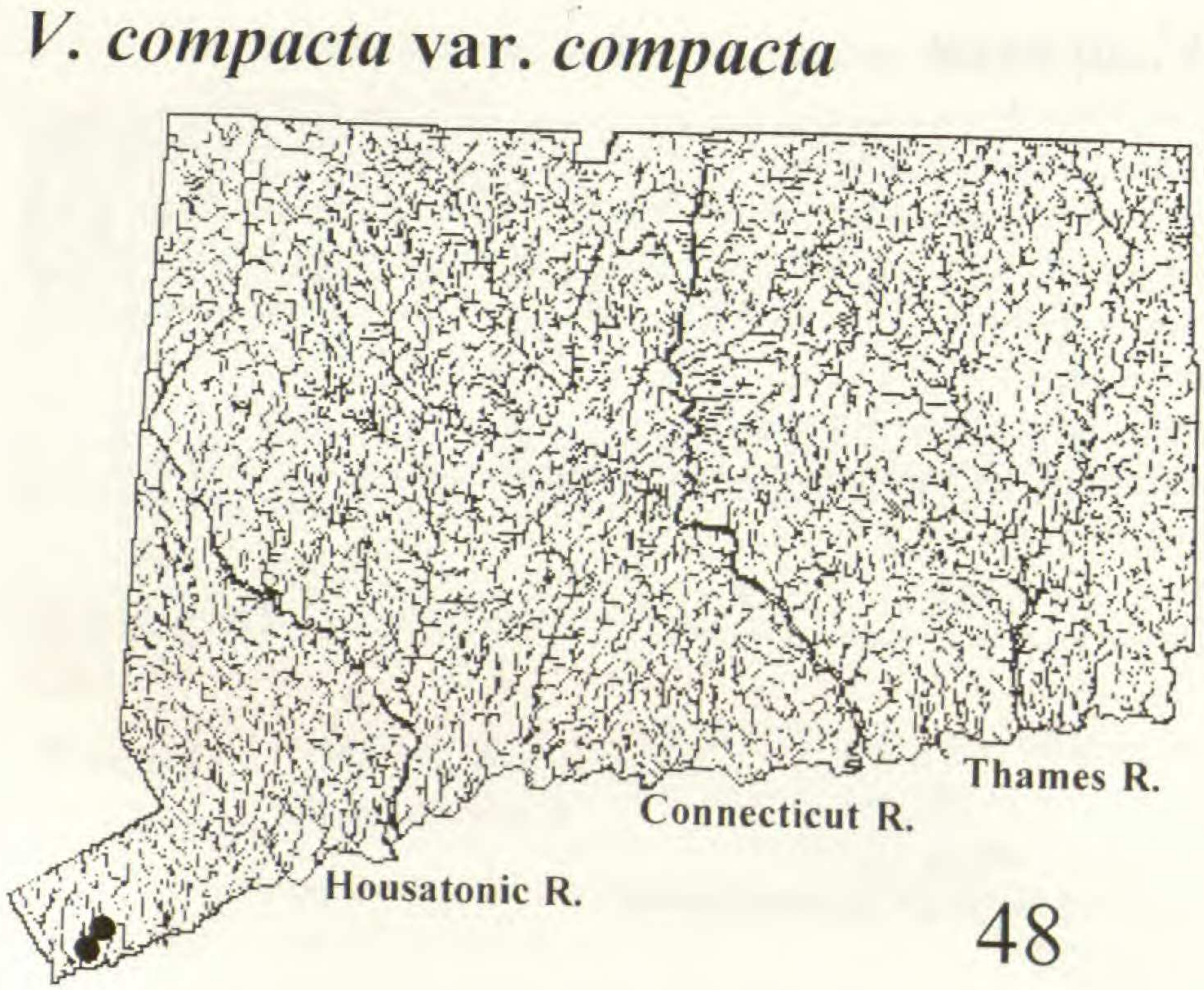
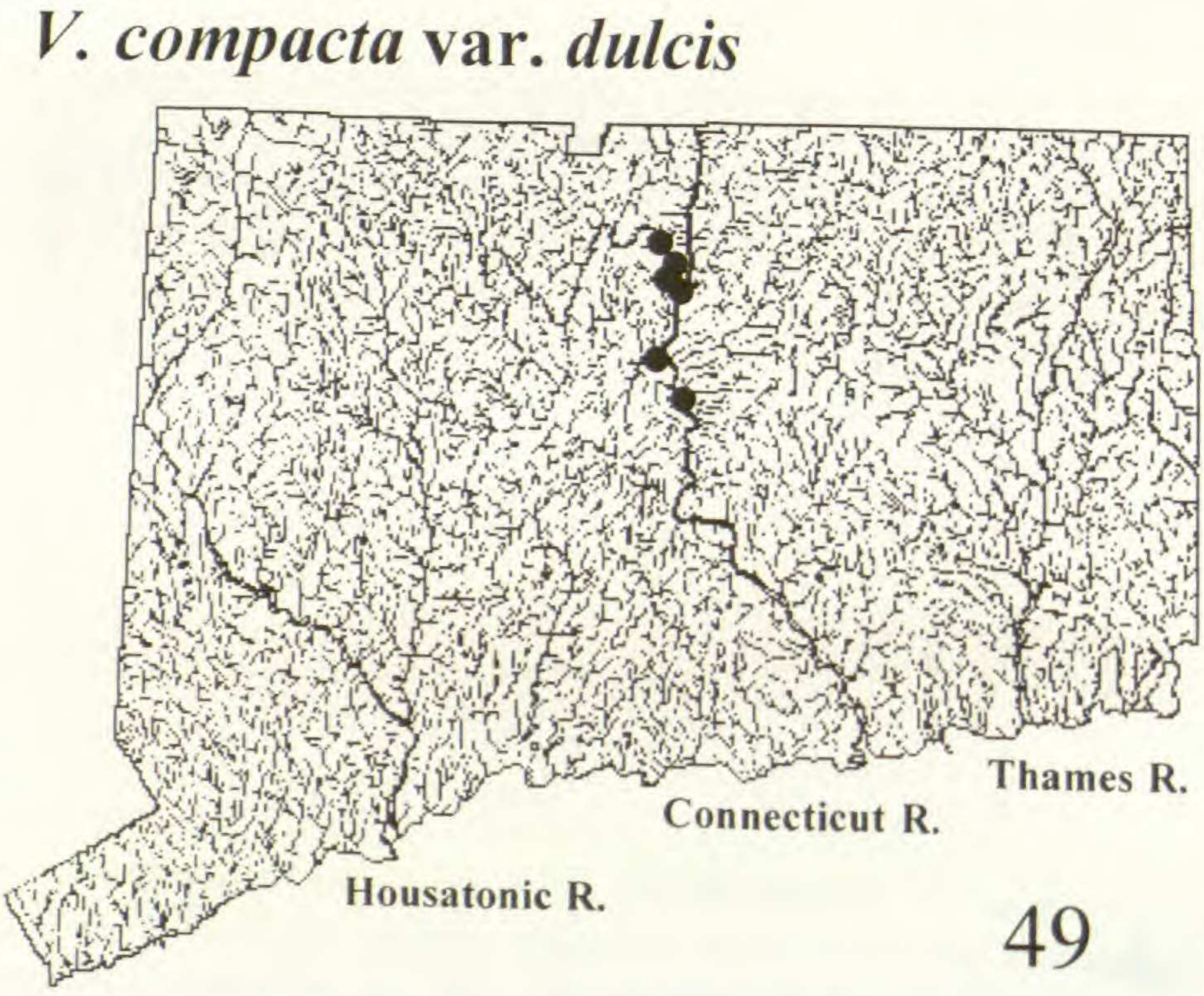
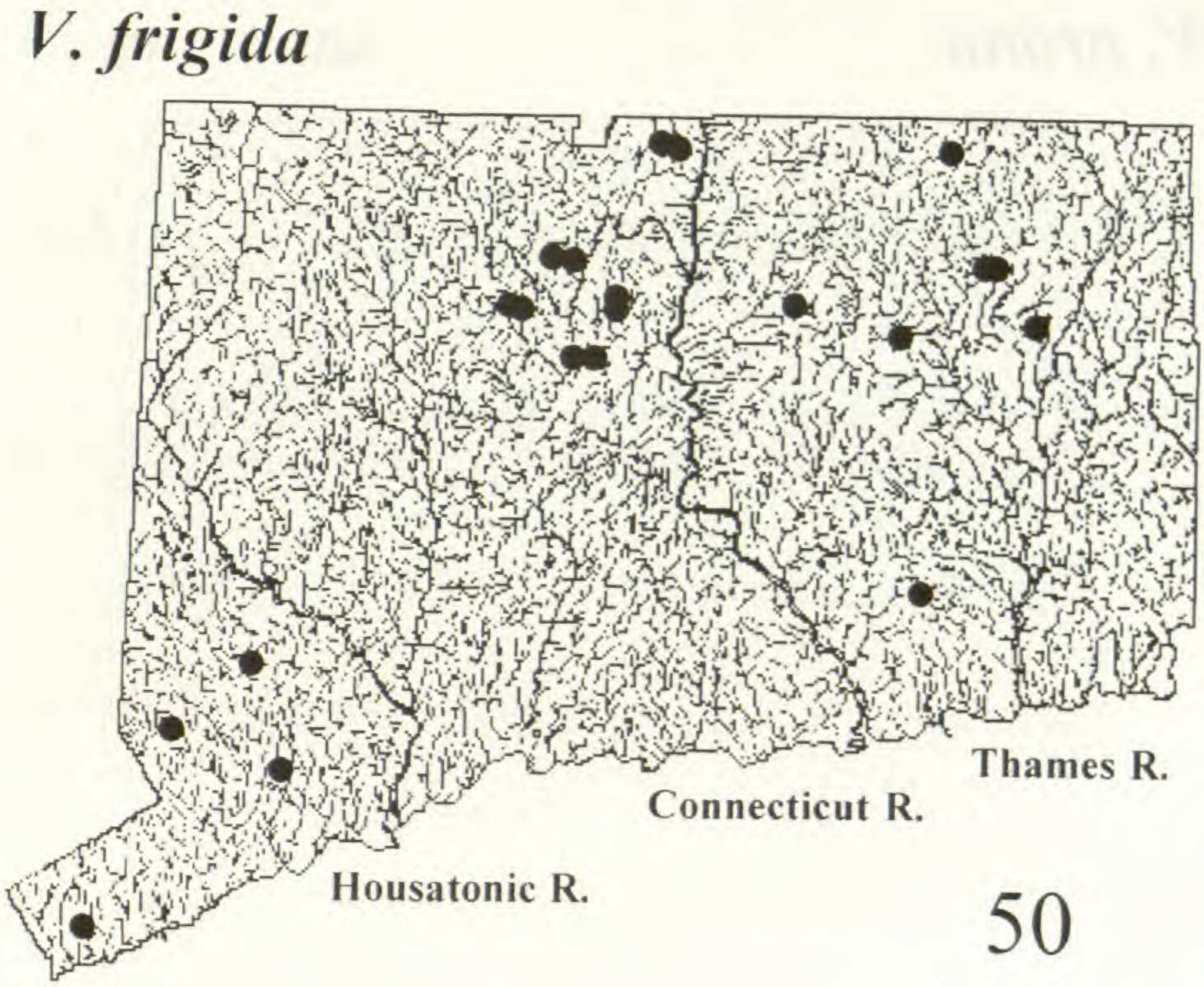
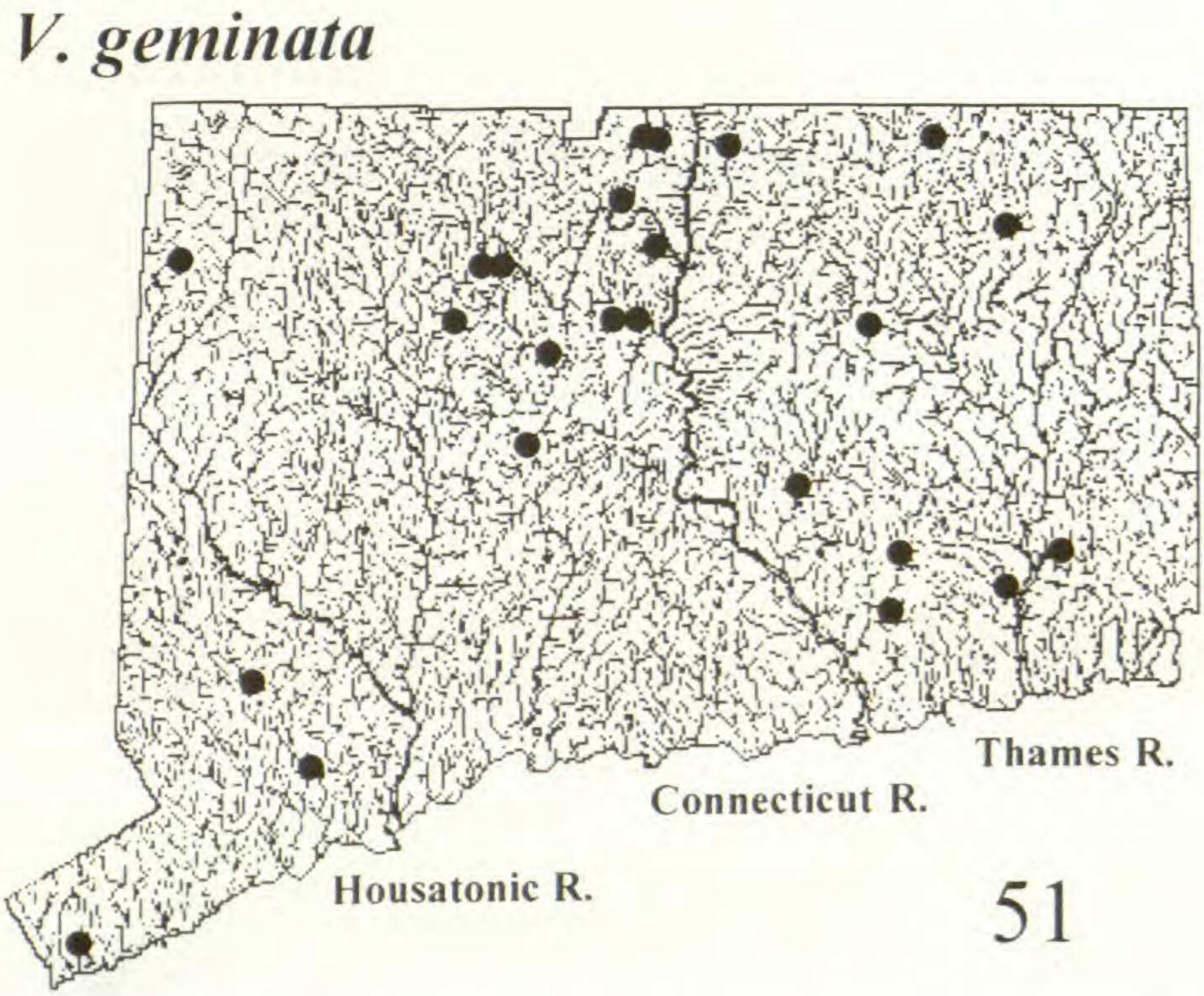
Figures 46–47. Distribution maps of Connecticut freshwater *Vaucheria* species.





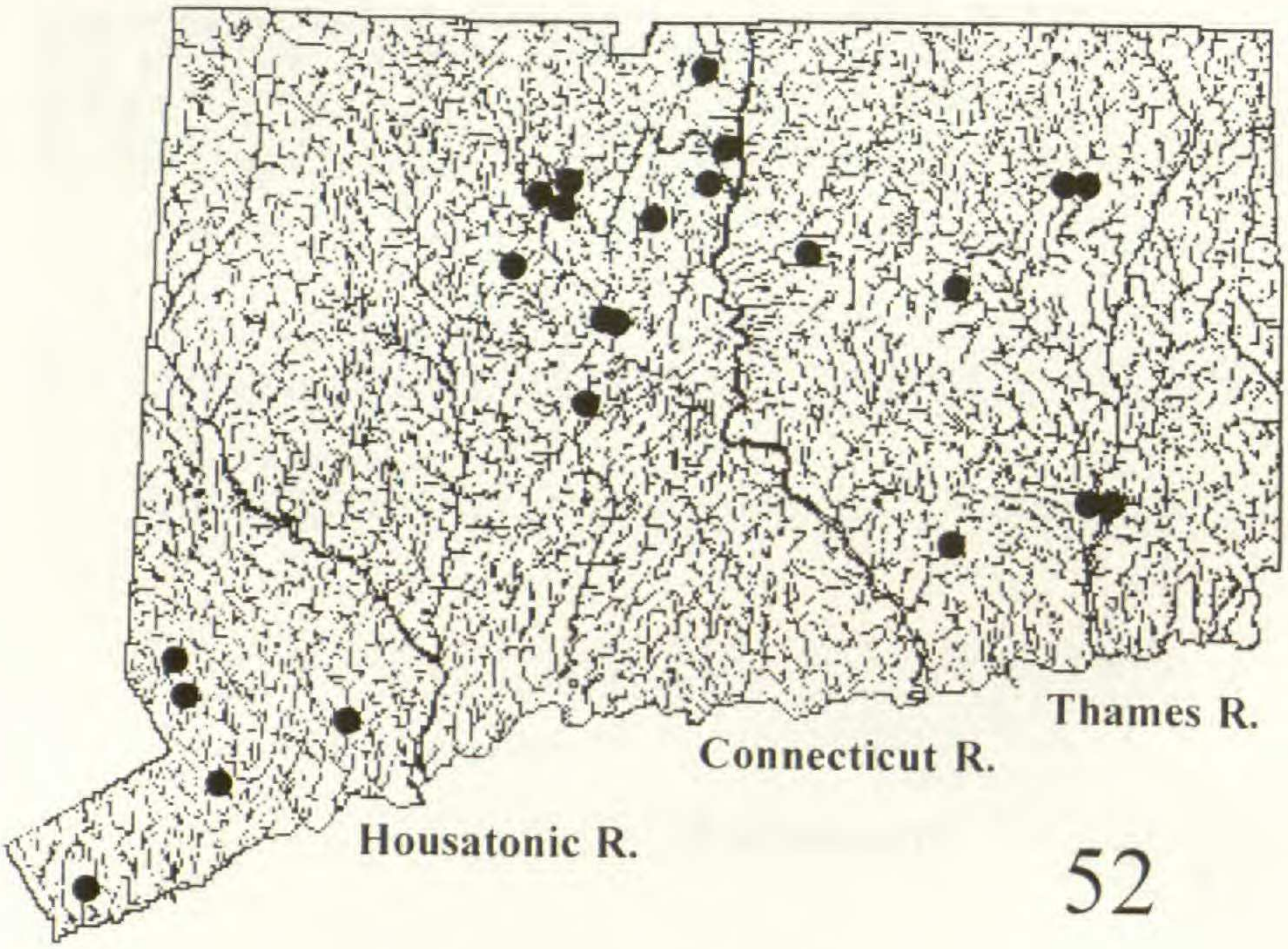
Figures 48–49. Distribution maps of Connecticut freshwater *Vaucheria* species.



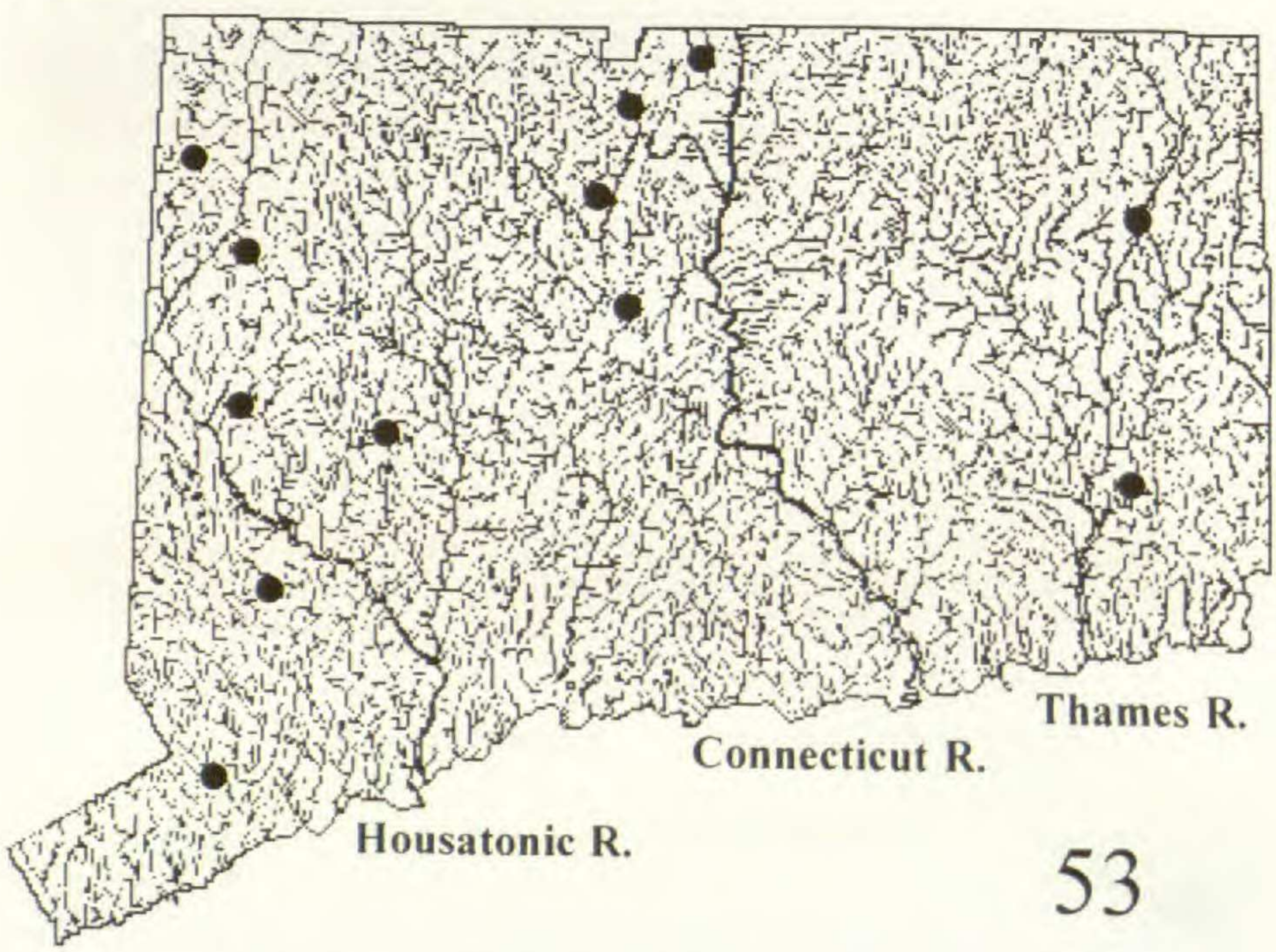


Figures 50–51. Distribution maps of Connecticut freshwater *Vaucheria* species.

V. prona

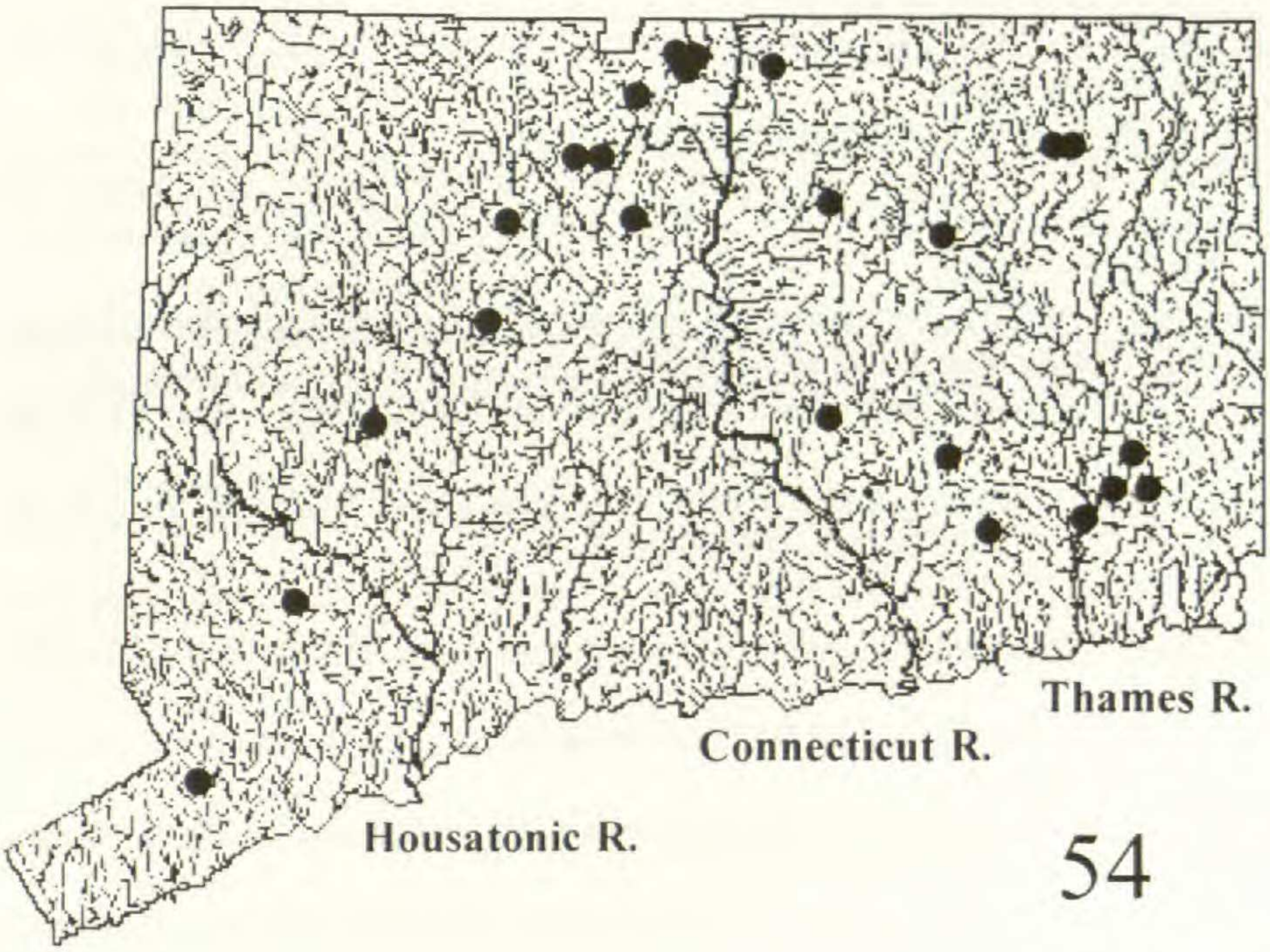


V. taylorii

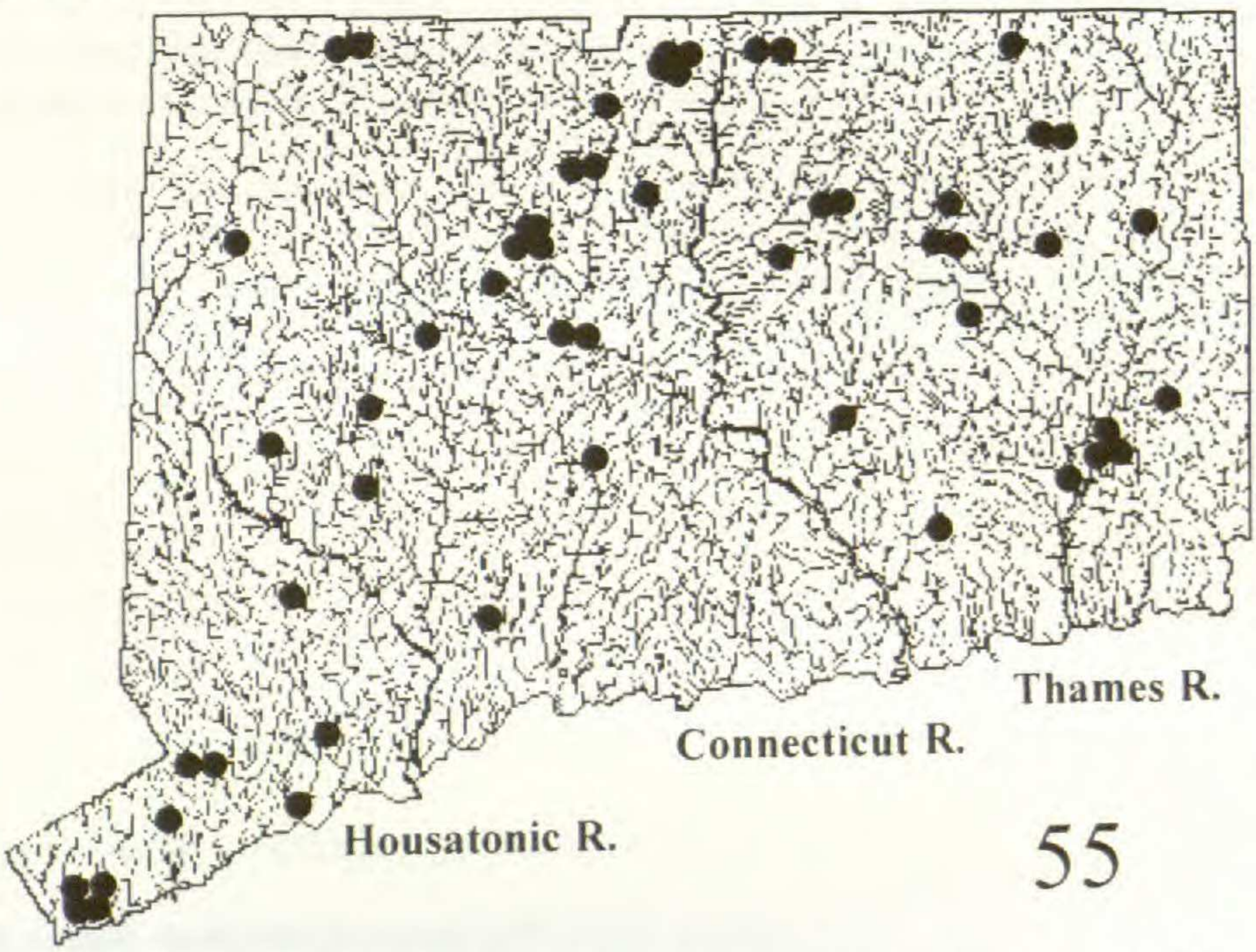


Figures 52–53. Distribution maps of Connecticut freshwater *Vaucheria* species.

V. uncinata



V. undulata



Figures 54–55. Distribution maps of Connecticut freshwater *Vaucheria* species.

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APPENDIX

FRESHWATER COLLECTION SITE CODES.

AB — Tolland Co.: Ash Brook, Coventry.
AC — Fairfield Co.: Ash Creek, Bridgeport.

AR — New London Co.: Blissville Brook, Lisbon.
BBB — Hartford Co.: Beamans Brook, Bloomfield.
BBR — Litchfield Co.: Blackberry River, North Caanan.
BBS — New London Co.: Big Brook, Salem.
BK — Windham Co.: Blackwell Brook, Brooklyn.
BNB — Litchfield Co.: Butternut Brook, Litchfield.
BPG — Fairfield Co.: Bruce Park, Greenwich.
BRWB — Hartford Co.: Tunxis Floodwater Retention Reservoir, Wash Brook, Bloomfield.
BSP — Fairfield Co.: Bible Street Park, Greenwich.
BUR — Hartford Co.: Burlessons Brook, Suffield.
CB — Tolland Co.: Brook off Route 44, Coventry.
CCR — New London Co.: Cato Corner Road, Colchester.
CD — Fairfield Co.: Carrington Drive roadside ditch, Greenwich.
CLB — Tolland Co.: Columbia Lake Brook, Columbia.
CM — Hartford Co.: Copper Mine Brook, Bristol.
CP — Hartford Co.: Covilli's Pond, Canton.
CPG — Fairfield Co.: Capalbo Place, Greenwich.
DL — New Haven Co.: Lake Dawson, Woodbridge.
DLF — New Haven Co.: Cow Pen Hill Road, Madison.
EA — Litchfield Co.: East Aspetuck River, New Milford.
EGST — Hartford Co.: Tributary Salmon Brook, East Granby.
EMR — New Haven Co.: East Mountain Reservoir, Prospect.
FMT — Hartford Co.: Farmington River, Tariffville mill, Simsbury.
FP — Hartford Co.: Farmington River, Poquonic/Windsor.
FS — Hartford Co.: Farmington River, Simsbury.
FTS — Hartford Co.: Farmington River, Curtiss Fields, Tariffville/Simsbury.
FW — Hartford Co.: Farmington River, Windsor.
FWB — Hartford Co.: Freshwater Brook, Enfield.
GMS — Hartford Co.: Mountain Brook, Great Marsh, Suffield.
GRDD — Hartford Co.: Gracey Road drainage ditch, Canton.
GSB — Hartford Co.: Salmon Brook, Granby.
HB — New Haven Co.: Junction Route 5 and Interstate 691, Meriden.
HLM — Hartford Co.: Hockanum River, Laurel Marsh, Manchester.
HOR — Litchfield Co.: Housatonic River, Sharon.
JB — Hartford Co.: Jim Brook, Canton.
KFB — Litchfield Co.: Kent Falls Brook, North Kent.
KP — Fairfield Co.: Kent Pond, Wilton.
LBM — New London Co.: Latimer Brook, Montville.
LEL — New London Co.: Latimer Brook, East Lyme.
LJB — Hartford Co.: Lower Jim Brook, Canton.
LR — Windham Co.: Little River, Hampton.
LV — Hartford Co.: Farmington River, Farmington.
MB — Fairfield Co.: Miry Brook, Danbury.
MNE — Tolland Co.: Junction Eaglesville Road/Hunting Lodge Road, Storrs/Mansfield.
MP — Hartford Co.: Drainage catchment basin (pond), Interstate-84, Manchester.

NB — Fairfield Co.: North Brook, Newtown.
NBBB — Hartford Co.: North Branch Bunnel Brook, Burlington.
NCM — Fairfield Co.: Mill Pond, New Caanan.
NCWR — Litchfield Co.: Witing River, North Caanan.
NH — Hartford Co.: Drainage ditch, Route 30, South Windsor.
NK — Windham Co.: Nipmuck Trail, Ashford.
NN — Litchfield Co.: Nonnewaug River, Woodbury.
NR — Fairfield Co.: Norwalk River, Ridgefield.
NRS — Hartford Co.: Floodplain vic. Wells Pond, West Hartford.
PB — Fairfield Co.: Patterson Brook, Easton.
PBW — Hartford Co.: Phelps Brook, Windsor.
PGB — Hartford Co.: Plum Gully Brook, South Windsor.
PN — Fairfield Co.: Montgomery Pinetum, Greenwich.
PR — Litchfield Co.: Pequabuck River, Plymouth.
PTB — Litchfield Co.: Purgatory Brook, Watertown.
QP — Hartford Co.: Quinnipiac River, Southington.
QR — Windham Co.: Quinebaug River, Brooklyn.
RGB — Hartford Co.: Rocky Gutter Brook, Suffield.
RP — Hartford Co.: Reservoir pond, West Hartford.
RPC — Hartford Co.: Riverside Park, Connecticut River, Hartford.
RRB — Tolland Co.: Valley Falls Park, Vernon.
RRD — New London Co.: Drainage ditch, Roosevelt Road, Norwich.
SBBB — Hartford Co.: South Branch Bunnel Brook, Burlington.
SCR — Hartford Co.: Scantic River, Enfield.
SDD — New London Co.: Route 11 drainage pond, junction Route 82, Salem.
SKR — Tolland Co.: Skungamaug River, Coventry.
SNR — Fairfield Co.: South Norwalk Reservoir, Wilton.
SR — Middlesex Co.: Salmon River, East Hampton.
ST — New London Co.: Shetucket River, Taftville.
TAB — New London Co.: Taftville area brook, Lisbon.
TD — Tolland Co.: Taylor Road, railroad cut drainage ditch, Vernon.
TMR — Hartford Co.: Lazy Lane Road, Southington.
TR — New London Co.: Shetucket River, Norwich.
TSB — New Haven Co.: Transylvania Brook, Southbury.
US — Tolland Co.: Stream, Route 171, Union.
WBB — Hartford Co.: Wash Brook, Bloomfield.
WBSP — New Haven Co.: Wharton Brook State Park, outlet brook, Wallingford.
WCP — Hartford Co.: Woodridge Circle Pond, Canton.
WHR — Hartford Co.: West Hartford Reservoir, West Hartford.
WMR — Fairfield Co.: Stream, Wire Mill Road, Stamford.
WP — Hartford Co.: Wells Pond, West Hartford.
WPF — Hartford Co.: Wells Pond feeder stream, West Hartford.